IOT based Smart Crop Suitability System

Design Document

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DECLARATION

I hereby declare that the project work entitled "IOT based Smart Crop Suitability System" submitted to the Sri Lanka Institute of Information Technology, is a record of original work done by our group under the guidance of Dr. Anuradha Jayakody (Supervisor), and this project work is submitted in the fulfilment of the award of the Bachelor of Science (Honors) in Software Engineering Specialization in Information Technology. The results embodied in this report have not been submitted to any other University or Institute for the award of any degree or diploma. The diagrams, research results and all other documented components were developed by me and I have cited clearly any references I have made.

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1. INTRODUCTION

1.1. Purpose

The purpose of this document is to present detailed description of generating the future fertilizer plan for the selected crop for a successful cultivation of "IOT based Smart Crop Suitability System" application. The document will explain the purpose and features, the interfaces, what the system will do and the constraint under which it must operate.

1.2. Scope

This document covers the requirement for generating the future fertilizer plan for the selected crop for a successful cultivation of "IOT based Smart Crop Suitability System" application. The main goal in this component is to maintain the growth of the crop to achieve a successful cultivation. To obtain the main goal, this component has consists of four objectives such as,

- Store sensor data in cloud server.
- Generate the future fertilizer plan.
- Notify the user properly.
- Manage future defects of the crop.

For the future purposes, the gathered sensor data will be securely stored in a cloud server and process with in built data set which stored in the mobile application, using data mining technique in machine learning algorithms [1] in order to generate the future fertilizer plan for the selected crop. The fertilizer plan consists of the fertilizer amounts that should apply to the selected crop with the accurate time period. The user will get notifications with the help of the mobile application about the fertilizers that should apply for the crop according to each time period in the generated fertilizer plan. Also this will give user the ability to find the solutions for any defect that will occur in the growth time period of the crop. The solutions will be generated by using machine learning algorithms.

1.3. Definitions, Acronyms, and Abbreviations

RAM	Random Access Memory
User	A person who is using the smart crop suitability application
WIFI	A facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.

Table 1: Definitions, Acronyms, and Abbreviations

1.4. Overview

The first chapter focused on the introduction to this application. This application is mainly targeted for generating the most suitable crop for a particular ground and maintain the growth of that selected crop. By predicting the most suitable crop with a particular future plan will lead a successful cultivation with minimum cost.

The second chapter explains the overall description of the functionality and interaction with other components. This section also discuss the interfaces, constraints and operations to provide better understanding about the product. Moreover, it explains user characteristics, system constraints, and comparison with an existing product, assumptions, dependencies and apportioning of requirements.

In the third section of the document, all user requirements, hardware and software requirements, architectural diagram, budget, and the risk mitigation plan details are described clearly. This will be more helpful to the developers as all the essential details are provided it will be much easier to deal with developing process.

All the supporting information and the references are mentioned at the final part of the document. Throughout the document, all the details of the proposed product are described in detailed.

2. OVERALL DESCRIPTIONS

Generating the future fertilizer plan after successfully predicting the most suitable crop for a particular ground is a key point in this application. The gathered soil data by sensors will be stored in the cloud for the future use. The stored data will then perform the process of generating the future plan for the selected crop, with an in-built data set by using machine learning techniques.

The future fertilizer plan includes the relevant time periods with the amount of fertilizers that should apply for the crop to achieve a successful cultivation. User will be notified according to each time period in the generated fertilizer plan. By applying those methods in the accurate time will guide user to have a successful cultivation.
The system will also give user the ability to search accurate solutions for any defects of the crop in the time period of growth.

2.1. Product Perspective

There are many types of researches based on predicting the crop growth by using different tools and techniques. According to the researchers Joon-Goo Lee and Haedong Lee, they have used image processing techniques for develop same kind of an app. [2]

Also most of the products use either expensive sensors or chemicals for the soil tests. But in this proposed system will develop a tool with attaching sensors which will test the main factors like pH, electrical conductivity (EC) of the soil and temperature, humidity of the air.

The future fertilizer plan will be generated according to the data gathered through sensors with processing in-built data set in the mobile application. Because the in-built data set will store not in the cloud storage, but within the mobile application, the user does not need to download the data set to the mobile phone each and every time when he/she uses the application.

2.1.1. User Interfaces

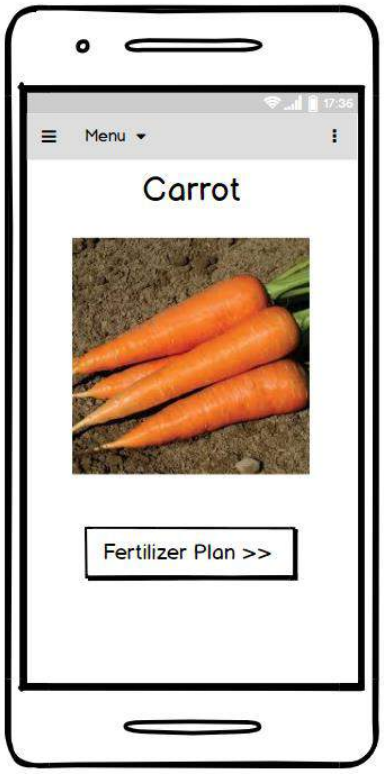

Figure 1 : User interface - navigate to view fertilizer plan

Figure 2: User interface - View fertilizer plan

Figure 3: User interface - Search solutions for the defects in crop

2.1.2. Hardware Interfaces

- pH sensor
- EC sensor
- Temperature sensor
- Humidity sensor
- Raspberry pie
- Smart phone

2.1.3. Software Interfaces

Visual studio 2016	Developing cross platform mobile application
phpMyAdmin	MYSQL database management
Cloud	To store the sensor data and in-built data set

Table 2: Software interfaces

2.1.4. Communication Interfaces

To process all the operations, this proposed system will use Raspberry pie board. So the system will use an API in order to communicate between cloud and the raspberry pie. Also the smartphone should be connected to the internet through mobile data or WIFI.

2.1.5. Memory Constraints

The mobile application is required,

- Android version should be 5.0 or higher.
- 1GB RAM
- 100MB memory space

2.1.6. Operations

- User should enter area of the ground.
- Ground details and sensor details should store in the cloud.
- Data processing will done by Raspberry pie.
- User has the ability to find solutions for the issues of the crop.
- Mobile application should display generated output to the user.
- For the internet facility, mobile data or wifi should be enabled.

2.2. Product Functions

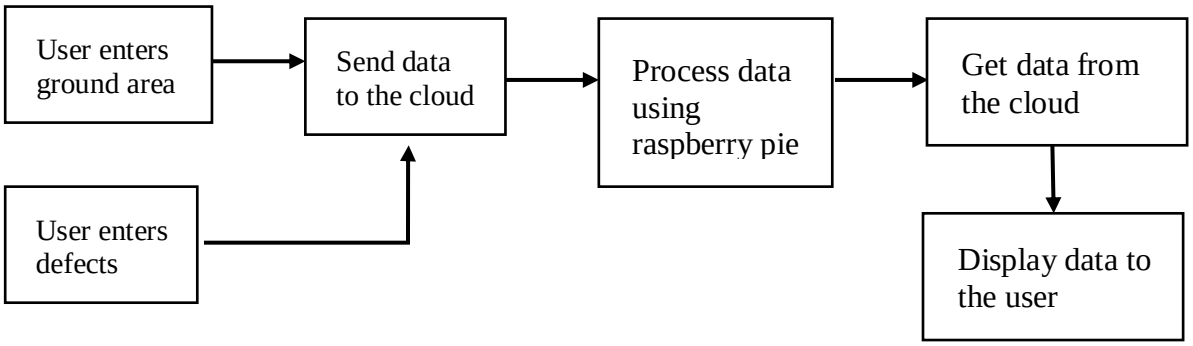

Figure 4: High level diagram of product functions

- User enters ground area

  User enters the area of the ground which he/she planning to process the cultivation.

- User enters defects

  User enters any defects while occurs in the growing period of the crop, in order to find the accurate solutions.

- Send data to the cloud

  Cloud storage will be used to store the data user entered for the future calculation processes.

- Process data using Raspberry pie

  Raspberry pie board will be used for data processing using machine learning algorithms. The processed data will be send back to the cloud through an API.

- Get data from the cloud

  Get processed data from the cloud in order to display to the user

- Display data to the user

  User can view the processed data through the mobile app.

  - Future fertilizer plan.
  - Notifications.
  - Solutions for the defects.

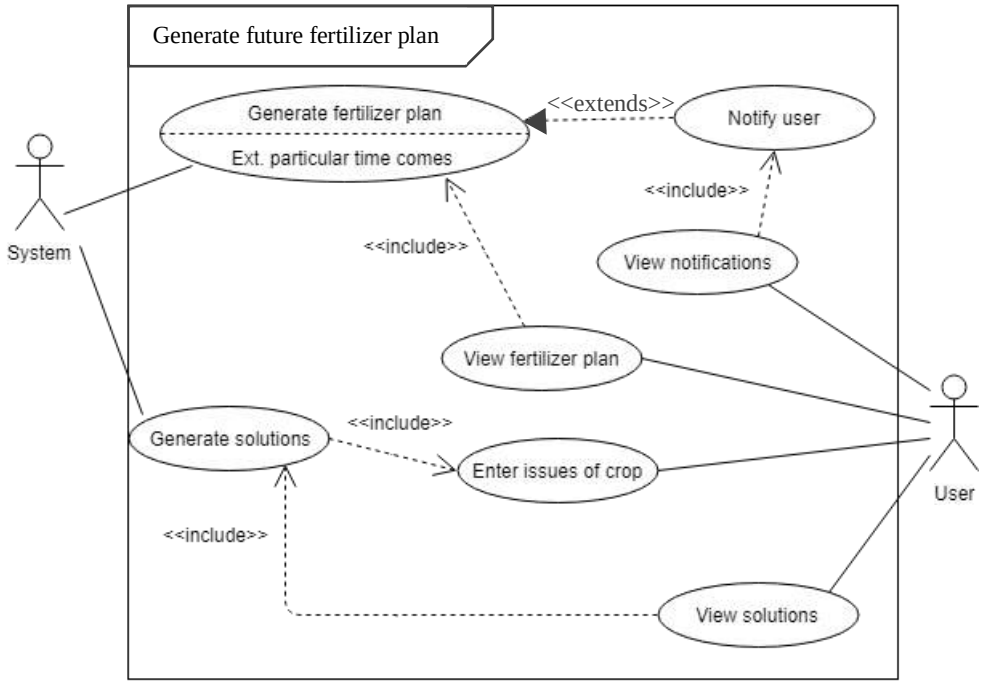

Figure 5: Use case diagram

Use Case Scenario

Use case 01	Generate fertilizer plan
Primary Actor	System
Pre-condition	System should generate the most suitable crop
Main success scenario	1. User clicks on “Generate fertilizer plan”
Extensions	If the accurate time period occurs, system should notify user according to the methods in fertilizer plan.

Table 3: Use case scenario - Generate fertilizer plan

Use case 02	Generate solutions
Primary Actor	System
Pre-condition	User should enter issues of the crop
Main success scenario	1. User enter the issue 2. User clicks “Search solutions” 3. System will display accurate solutions
Extensions	-

Table 4: Use case scenario - Generate solutions

2.3. User Characteristics

This system is mainly focused on people who has an interest in cultivation. Because the system provides the ability to predict the most suitable crop for the particular ground, even the people who does not have much knowledge on cultivation can use this app without easily. Furthermore, user can maintain the future growth of the selected crop by following the methods in the generated fertilizer plan.

2.4. Constraints

- A smartphone is required with enough battery life and storage.
- Raspberry pie board is required to do the data processing using machine learning algorithms.
- The performance should be user friendly along with the other software facilities.

2.5. Assumptions and dependencies

- The smartphone is switched on throughout the process of generating results with the enough power of battery.
- Internet connectivity will be available in the smartphone through the process.
- User will proceed all the methods according to the fertilizer plan.

2.6. Apportioning of requirements

- Essential Requirements
  - Send the user entered ground area details and store in the cloud.
  - Allow the user to view the future fertilizer plan.
  - Allow user to search solutions for issues of the crop.
  - Display the accurate solutions for the searched issue.

- Desirable Requirements
  - The user should notify when the accurate times occurs according to the fertilizer plan.

3. Specific Requirements

3.1. External interface requirements

3.1.1. User interfaces

- Navigate to fertilizer plan
  - User can view future fertilizer plan according to the selected crop by clicking “Fertilizer plan”.
- View fertilizer plan
  - User can view the fertilizer plan with the methods he/she should follow according to the time period to have a successful cultivation.
- Search solutions
  - User can search solutions for the issues in crop by searching the issue.

3.1.2. Hardware interfaces

- pH sensor - to identify pH level of the soil
- Temperature sensor - to identify the temperature of the soil
- Humidity sensor - to identify the water level of soil
- Electricity conductivity sensor - to measure ability to conduct electricity
- WIFI module - for communication purpose between the mobile, smart crop suitability tool
- Smart phone - for the mobile application, suggest crops, show locations and user will be notified through the mobile. (Android version 6.0 or higher)
- Raspberry bi 3 model b+ –as the sensor hub

3.1.3. Software interfaces

Name	Version	Purpose
Visual Studio	2015 or higher	Developing cross platform mobile application
phpMyAdmin	Php version 5.5.12 or higher	MYSQL database management

3.1.4. Communication interfaces

Mainly in this component the communication process will be happened through the WIFI connectivity. Therefore, raspberry pi and phone is connected always to retrieve data. As well for the communication between the application and database, and for crowdsourcing, internet facility should be enabled.

Moreover, the smart crop suitable system will get the current location using GPS module.

3.2. Architectural Design

3.2.1. High level Architectural Design

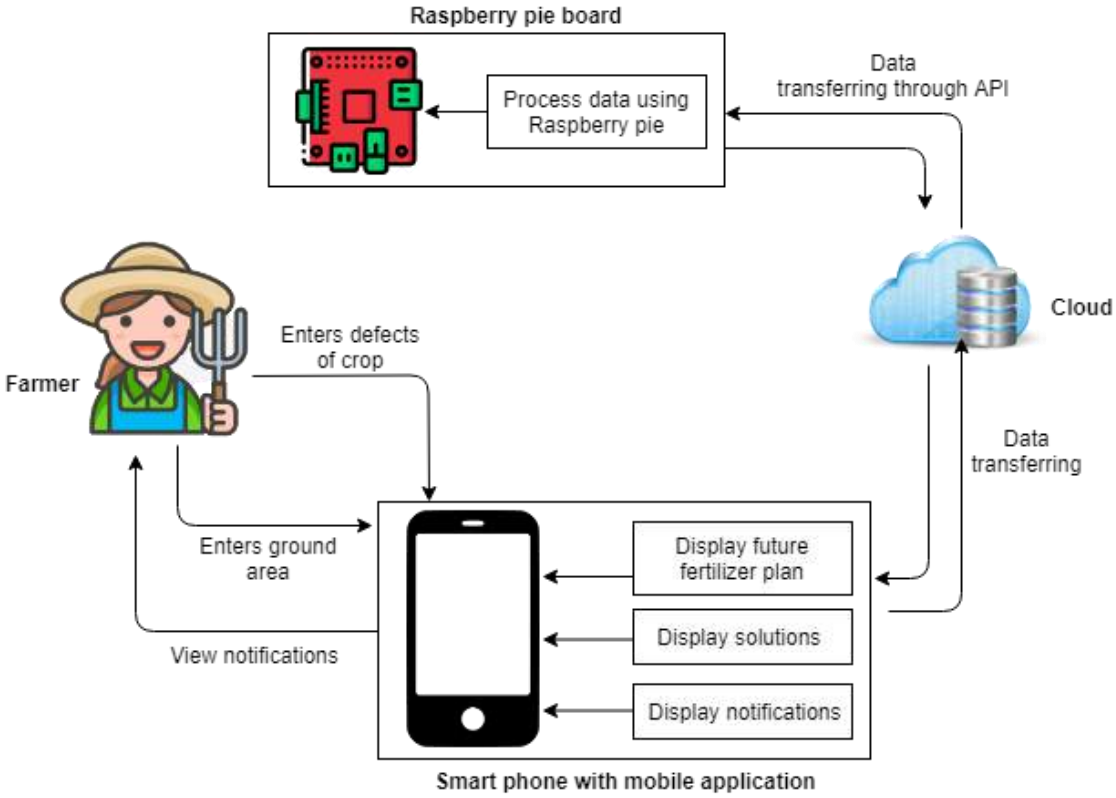

Figure 6: High level architectural design

3.2.2. Hardware and Software requirements with justification

As our proposed product will address to a common issue for the people who has an interest in cultivation, the final outcome should be more effective and accurate. Therefore, several software and hardware components have to be used for achieving this.

Hardware requirements

- pH sensor - Use to check the quality of the soil in a particular ground.
- EC sensor - Use to get the electrical conductivity of the soil.
- Humidity sensor - Use to identify the humidity of the air.
- Temperature sensor - Use to identify the temperature in the air.

Software Requirements

- Visual studio 2015 – Use to develop the mobile application using Xamarine.
- phpMyAdmin – To perform MYSQL database management.

- Cloud – To store sensor readings and the area of the ground.

3.2.3. Risk mitigation plan with alternative solution identification

Risk	Impact	Likelihood (%)	Mitigation Plan
pH Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
Humidity Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
temperature Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
EC Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
If there no network coverage in this place	1	50%	Save the data mobile phone and after available network saved in the database
Machine learning algorithm result is less accurate	3	30%	Train the algorithm using more data sets

Table 5: Risk mitigation plan

3.2.4. Cost benefit analysis for the proposed solution

Description	Quantity	Price (Rs)
Ph Sensor	1	350.00
Humidity sensor	1	350.00
Temperature Sensor	1	200.00
EC meter	1	450.00
HDMI to VGA adaptor	1	1225.00
Raspberry Pie 3 kit	1	7450.00
Screen for raspberry pi	1	1400.00
Memory card 16GB	1	1500.00
	Total	**12925.0**

Table 6: Cost benefit analysis

3.3. Performance requirements

It is expected that the proposed system will perform all the requirements stated under the functional requirements section. Some performance requirements identified are listed below.

- The sensor readings must be accurate and trustworthy.
- The mobile application performance is going to depend on mobile phone's battery life, RAM and internet connectivity.
- Sensor details can transfer within less than one second.
- The system will operate with minimum 1GB RAM.

3.4. Design constraints

This product is focused on people without any age limitation, the user interfaces of the mobile application have to be simple, attractive as well as user-friendly. Therefore, people will be able to work with the proposed product easily and effectively with the use of these designed user interfaces.

3.5. Software system attributes

3.5.1. Reliability

As this product address a common issue of people who has an interest in cultivation, the reliability of the proposed product is important. According to this research component,

- The sensor readings must be 100% accurate because most important actions will be based on them.
- To data communication between cloud, internet connectivity should be enabled.
- The system will be tested using several techniques to make sure it's probability of failure is very low value.
- If there will be a failure in the system a proper mechanism is going to be implemented to show the failures.
- At a time of failure, there should be a way to overcome through that immediately.

3.5.2. Availability

- Always servers need to be available because this system functions working with server data.
- This application should be a real-time application. It is working with real-time data.
- When a user needs mobile phone reset or changes the mobile. We are going to implement the backup option to recover user details.
- The sensor sub system and the mobile application should be easily understandable to users and it should be real time

3.5.3. Security

For user sign up for the mobile application, unique email address or phone number needs to be used by the user. The login details of the user will be sent to the database in the encrypted version. Therefore, user details and other personal details will be secured.

3.5.4. Maintainability

The sensor sub system will be used to get the data through sensors. Other algorithms and functions to process the accurate results will be handled by using the Raspberry pie board and the cloud server. Therefore, if any change occurs in the system, it will be easier to maintain that situation by using an application update or changing the server data.

4. Supporting information

4.1. Appendices

[1]. S. Pudumalar, E. Ramanujam, R. H. Rajashree, C. Kavya, T. Kiruthika, and J. Nisha, "Crop recommendation system for precision agriculture," *2016 8th Int. Conf. Adv. Comput. ICoAC 2016*, pp. 32–36, 2017.

[2]. J. G. Lee, H. Lee, and A. Moon, "Segmentation method of COI for monitoring and prediction of the crop growth," *Int. Conf. ICT Converg.*, no. 2, pp. 640–641, 2014.